

June 15, 1965

R. E. DUPUY
TIME KEEPING APPARATUS

3,188,792

Filed July 31, 1963

3 Sheets-Sheet 1

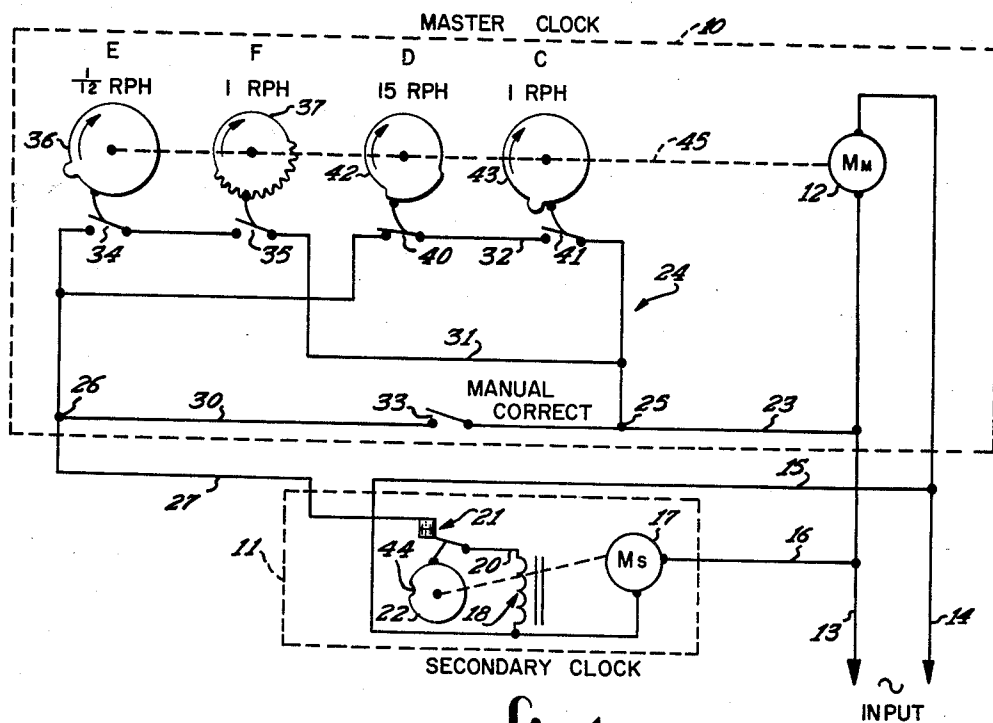


Fig 1

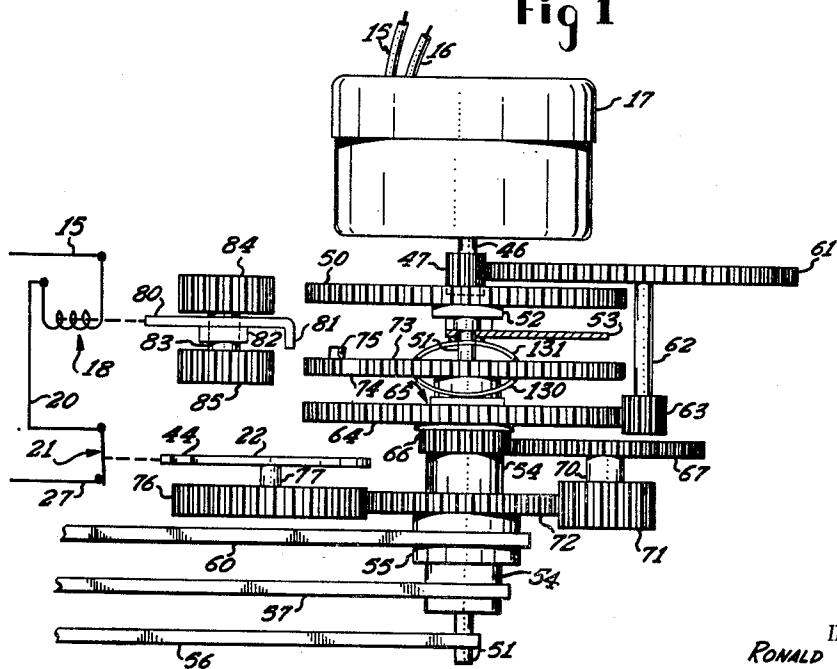


Fig 2

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3 Sheets-Sheet 2

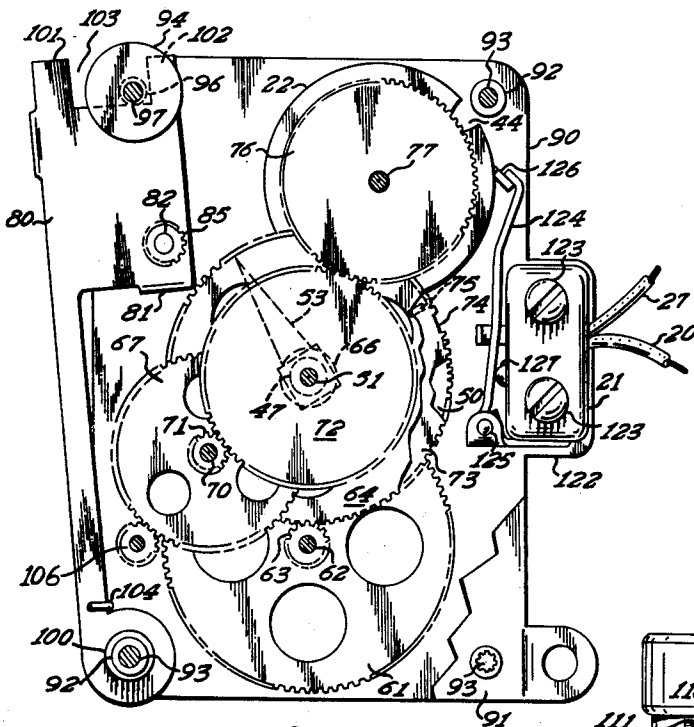


fig 3

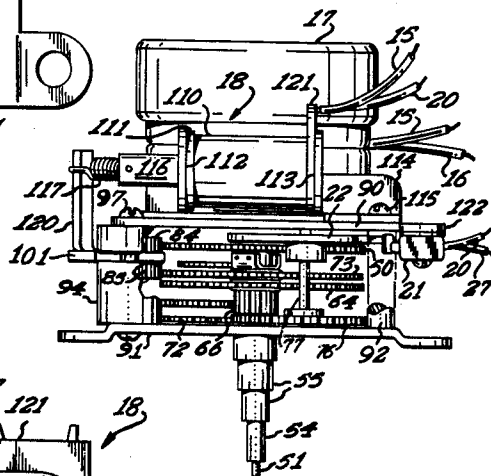


fig 5

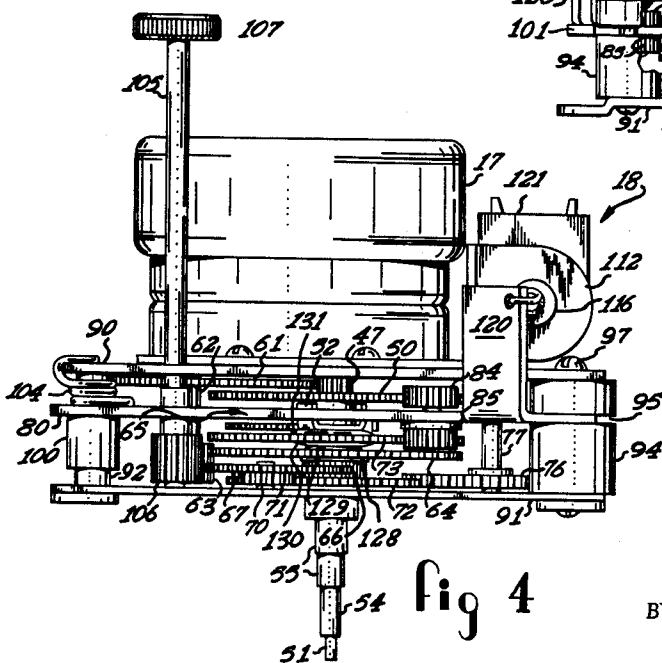


fig 4

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3 Sheets-Sheet 3

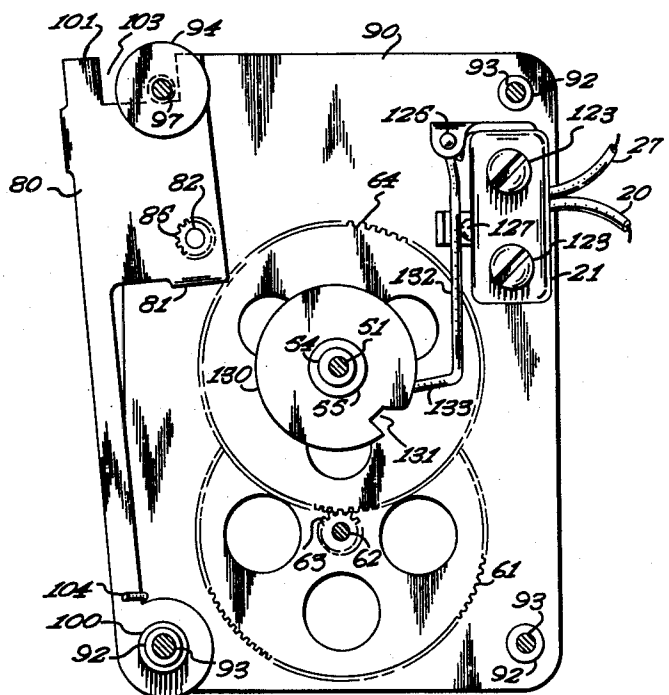


fig 6

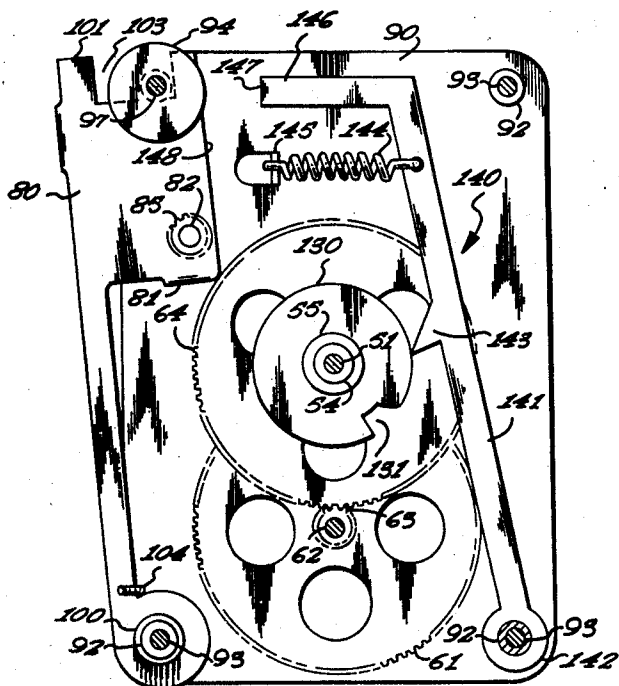


fig 7

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TIME KEEPING APPARATUS

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8 Claims. (Cl. 58—35)

The present invention relates to time keeping apparatus and more particularly to secondary clocks and similar time keeping devices of the type normally driven by individual driving motors such as synchronous alternating current motors, and which are automatically corrected at predetermined intervals in response to corrective signals transmitted from a source of correct or standard time such as a master clock.

In many installations, for instance schools, factories and commercial establishments where a large number of clocks are used, it is extremely important that all of the clocks be maintained in synchronism, that is that all of them indicate the same time. In such installations a single clock or a number of the clocks may be incorrect due to a temporary interruption of the electrical current to it or for various other reasons. In order to keep the clocks of such a system in synchronism, systems have been provided wherein the secondary clocks located in various positions in the building are all placed under the control of a master clock. This master clock keeps very accurate time and often includes a spring power reserve motor so that if the electrical power to it is interrupted the spring motor will continue to drive the master clock and maintain it at substantially the correct time. This master clock also includes means for transmitting correcting signals to the secondary clocks at predetermined times, these signals being effective to bring about a correction of the secondary clocks to bring the time setting of each of the secondary clocks into synchronism with the master clock.

In the past various mechanisms have been proposed for effecting a correction of a secondary clock upon receipt of a corrective signal from the master clock. Many of the proposed mechanisms have been found to be extremely complex and therefore not only very expensive to produce but also of questionable reliability. In addition many of these previous devices have been very noisy during the corrective operation and hence have caused a great deal of distraction in the room where the clock is located every time that a correction took place. This is particularly objectionable in classrooms.

The present invention provides an extremely simple and relatively inexpensive, but very reliable, means for accomplishing the correction of a secondary clock in response to signals transmitted by a master clock. The secondary clock includes a driving motor preferably of the synchronous alternating current type and at least one time member driven by the motor through an appropriate gear train so as to rotate the member at a normal time keeping rate. Operably connected to this time keeping member is a first corrective gear normally rotating at a predetermined rate. A second corrective gear is driven by the motor at a relatively higher rate. Upon receipt of a corrective signal from the master clock a pinion means is moved in a direction generally transverse to the axis of rotation of the pinions and the correction gears and into engagement with the first and second corrective gears in a manner so that the first corrective gear is driven at an accelerated rate to effect a rapid correction of the time keeping member. The first corrective gear has a blank portion on its periphery which is adapted to be adjacent the pinion means when the time keeping member is at a predetermined position. Thus if the time keeping member reaches this predetermined position some-

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time before the corrective signal is terminated, the drive of the first corrective gear is nevertheless interrupted at the desired position.

In a preferred embodiment of the invention, the time keeping apparatus is a conventional secondary clock having second, minute, and hour members driven by a synchronous motor through appropriate gear trains. The first corrective gear referred to above is connected to the minute member of this clock. The pinion means comprises a pair of rigidly connected rotatable pinions carried by a pivoted member normally maintained in a position so that the pinions are not in engagement with the corrective gears. Upon receipt of a corrective signal from the master clock this member is pivoted and brings the pinions into engagement with the two corrective gears thus causing an accelerated drive of the minute member. The pivoted member may also include an abutment member which is adapted, when in a correcting position, to engage a stop member carried by the seconds member when the seconds member reaches a predetermined angular position. The first corrective gear may also include a stop member adapted to engage the abutment member when the blank portion of the first corrective gear is adjacent the mating pinion.

In this system a twelve-hour correction may be accomplished by the master clock sending out a plurality of signals, each similar to the hourly signal, in rapid succession during one portion of each twelve hour period. When the secondary clock is in a correct position at the time this signal is received, means may be provided for breaking the circuit to the signal responsive member in the secondary clock so that further signals from the master clock will not cause further actuation of the corrective mechanism. In another embodiment mechanical means prevent the pivoted member from moving the pinions into engagement with the correction gears when the solenoid is energized during the twelve-hour correction if the secondary clock is correct at that time.

An object of my invention is to provide an improved secondary clock of the type adapted to be corrected automatically upon receipt of a corrective signal.

Another object of the invention is to provide a secondary clock as described above which is simple in construction, easy to assemble, relatively inexpensive, and reliable in operation.

A further object of my invention is to provide a secondary clock having means for automatically accomplishing a correction of said clock upon receipt of a corrective signal, which means is relatively quiet and hence is not distracting during the corrective operation.

These and other objects of the invention will become apparent upon reading the following detailed description of certain preferred embodiments of my invention in conjunction with the accompanying drawing wherein:

FIGURE 1 is a schematic representation of a clock system of the type in which the improved secondary clock of this invention may find application.

FIGURE 2 is a somewhat simplified, partially schematic, view illustrating the co-action of components of a secondary clock constructed according to my invention.

FIGURE 3 is a front view of a secondary clock built according to my invention with portions thereof broken away to better illustrate the component parts thereof.

FIGURE 4 is a top view of the secondary clock shown in FIGURE 3 when rotated 90° in the clockwise direction.

FIGURE 5 is an additional view of the secondary clock as seen from the top of FIGURE 3.

FIGURE 6 is a front view of a secondary clock with certain components removed, illustrating another embodiment of my invention.

FIGURE 7 is a front view, with certain components removed, illustrating a further embodiment of my invention.

FIGURE 1 illustrates schematically a system in which the secondary clock of the present invention may find application. This system includes a master clock, generally designated by the numeral 10, which is adapted to control a plurality of secondary clocks one of which is shown schematically at 11. Master clock 10 may be of any conventional type and will not be discussed in detail. The master clock is operated by a motor 12, designated Mm, which may be a synchronous electric motor and it is also to be understood that the master clock may include a spring power reserve motor which is effective to drive the clock in case of an interruption of electrical power to motor 12. This spring reserve motor is not shown but its use is well known in the clock art. Motor 12 is supplied with electrical current such as a normal 120 volt A.C. supply by a pair of electrical conductors 13 and 14.

Also connected across conductors 13 and 14, by conductors 15 and 16, and in parallel with motor 12, is a synchronous secondary clock motor 17, designated Ms, which powers the secondary clock 11. Secondary clock 11 also includes signal responsive means 18 shown schematically as an electromagnetic coil which has one terminal connected to conductor 15 and its other terminal connected, through a conductor 20, to a switch 21 which is operated by a cam 22 driven by the output of motor 17. As will be explained in detail later herein, signal responsive means 20, when energized, is effective to place in operation a corrective mechanism for synchronizing the secondary clock with the master clock.

Also connected to conductor 13 by a conductor 23 is a switching circuit 24 which has a first terminal 25 connected to conductor 23 and a second terminal 26 connected to a conductor 27 which is in turn connected to one of the terminals of switch 21 in the secondary clock.

Switching circuit 24 contains three parallel conductors 30, 31, and 32, electrically connected between terminals 25 and 26. Conductor 30 has interposed therein a manual switch 33. Conductor 31 has two switches 34 and 35 interposed in series therein, switch 34 being operable by a cam 36 and switch 35 by a cam 37. Similarly, conductor 32 has interposed therein a series combination of switches 40 and 41 operable by rotary cams 42 and 43 respectively. Cams 36, 37, 42, and 43 are driven by motor 12 through appropriate gear trains generally designated by the numeral 45.

In a typical installation an hourly corrective signal is provided through the action of cams 42 and 43 and switches 40 and 41 associated therewith. Cam 43 makes one revolution per hour and has a raised portion which is adapted to close switch 41 for a period of approximately one minute between the fifty-eighth and fifty-ninth minutes of each hour. Cam 42 makes fifteen revolutions per hour or in other words one revolution every four minutes. A raised surface on this cam is effective to close switch 40 for a period of approximately fifty-five seconds every fourth minute and the arrangement is such that switch 40 is closed between the fifty-eighth and fifty-ninth minute of each hour. Thus it can be seen that cam 43 provides a rather rough adjustment of the time at which a circuit is completed through conductor 32 and a fine adjustment of this time is provided by cam 42. When both switches 40 and 41 are closed a circuit is completed from conductor 13, through conductor 23, conductor 32, conductor 27 and switch 21 to signal responsive means 18 and through conductor 15 to conductor 14. At this time signal responsive means 18 is energized and an hourly correction of the clock takes place as will be discussed in detail hereinafter in connection with FIGURES 2 and 3 through 5.

Similarly a twelve-hour correction is accomplished by the action of cams 36 and 37 and their associated switches 34 and 35 respectively. Cam 36 makes one revolution

every twelve hours and has a raised portion which is adapted to close switch 34 between the hours of five and six of each twelve hour period. Cam 37 makes one revolution per hour and has a surface arranged to move switch 35 to a closed position at five minutes past each hour and then to effect cycling of switch 35 wherein the switch is closed for sixty-five seconds and opened for twenty-five seconds, this sequence being repeated for twelve cycles. At approximately twenty-three minutes past the hour, switch 35 is again moved to the open position and is maintained there until five minutes past the next hour. Thus between approximately 5:05 and 5:23 of each twelve hour period, twelve separate signals each having a duration of approximately sixty-five seconds and separated by approximately twenty-five seconds will be sent from the master clock.

Cam 22 in the secondary clock normally maintains the switch 21 in a closed position but the cam has a detent 44 which allows the switch to open when the secondary clock indicates approximately 5:03 and the switch 21 is maintained open until the clock indicates approximately 5:25. Thus if the secondary clock is correct when the twelve-hour correction signals are sent by the master, the circuit to signal responsive means 18 is broken and no correction of the secondary clock takes place.

While a single secondary clock is shown in FIGURE 1, it is to be understood that a plurality of secondary clocks may be connected in parallel with the master clock and be controlled thereby.

FIGURE 2 discloses, in simplified and somewhat schematic form, a secondary clock constructed according to the present invention. The clock is driven by a synchronous electric motor 17 which is adapted to be connected across a source of line voltage by conductors 15 and 16 in the general manner shown in FIGURE 1. Motor 17 has an output shaft 46 which has mounted thereon a pinion 47. Output shaft 46 normally rotates at 1 r.p.m. Also mounted on output shaft 46 is a corrective gear 50 which also rotates therewith. Immediately forward of corrective gear 50 is a seconds member or shaft 51 which is connected to gear 50 through a slip friction clutch arrangement 52. Mounted on seconds shaft 51 for rotation therewith is a seconds stop member 53. Seconds shaft 51 is journaled in a minutes member or sleeve 54 which in turn is journaled in an hour member or sleeve 55. At the forward end of the clock, shaft 51 protrudes beyond sleeve 54 which in turn protrudes beyond the end of sleeve 55. At their forward ends members 51, 54, and 55 may have mounted (by appropriate means not shown) indicating members such as hands 56, 57, and 60 respectively.

As indicated above, seconds shaft 51 is normally driven synchronously with output shaft 46 of the motor 17 through the slip friction or slip clutch arrangement 52. Minute member 54 is driven through a gear train including a gear 61 which engages pinion 47 and which is fixed to a shaft 62 having also fixed thereon a pinion 63. Pinion 63 engages a gear 64 which is mounted on minute sleeve 54 and connected thereto by a slip friction or clutch arrangement 65. Hour sleeve 55 is driven through a gear train including a pinion 66 rigidly mounted on minute sleeve 54 which is in engagement with a gear 67 fixed on a shaft 70. Shaft 70 also has fixed thereto a pinion 71 which engages a gear 72 fixed to the hour sleeve 55.

Rigidly mounted on minute member 54, at its rearward end, is another corrective gear 73, preferably having the same diameter as corrective gear 50 and co-axial therewith. Gear 73 has on its periphery a short angular blank portion 74, that is, a portion devoid of gear teeth. Gear 73 also has mounted on its rearward side, a short, generally radially extending, stop member 75. The purposes for blank portion 74 and stop 75 will be described later herein.

Gear 72 also engages a gear 76 fixed on a shaft 77 which also has mounted thereon the cam member 22 discussed in connection with FIGURE 1. Cam 22 rotates at the

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rate of one revolution every twelve hours and hence is synchronized with hour member 55. During each twelve hour period cam 22 maintains switch 21 in a closed position except for the period between approximately 5:03 and 5:25 corresponding to the interval determined by the angular length of detent 44 on cam 22. Thus, except for this relatively brief period during each twelve hour period, signal responsive means 18 is connected across conductors 13 and 14, as shown in FIGURE 1, through the switching circuit 24 and hence means 18 is in a position to be energized by a signal from the master clock.

The secondary clock mechanism also includes a movable member 80 having an abutment portion 81 formed thereon. Journalled in a bearing 82 on member 80 is a shaft 83 having rigidly mounted thereon a pair of pinions 84 and 85 arranged on shaft 83 so that one of the pinions is located on each side of member 80. Normally member 80 is maintained stationary in an inactive position wherein pinions 84 and 85 are not driven and form no part of the normal drive train for the device. Upon energization of signal responsive means 18, it is effective to move member 80 in a direction substantially perpendicular to the axis of rotation of the corrective gears and of the pinions to a correcting position wherein pinions 84 and 85 engage corrective gears 50 and 73 respectively thereby connecting the two gears so that corrective gear 73 is driven at an accelerated rate, namely the rate of the output shaft 46 of the motor. At the same time abutment portion 81 is moved to a position wherein it lies in the path of stops 53 and 75 to stop the seconds and minute members when they reach a predetermined position, for instance the vertical or twelve o'clock position on the clock. At this position a blank portion 74 on the periphery of corrective gear 73 is adjacent pinion 85 and the accelerated drive of the minute member is thus interrupted. At this time motor 17 may continue to run because of slippage at friction clutches 52 and 65, even though seconds member 51 and minute member 54 are stopped. Upon cessation of the corrective signal member 80 is moved to an inactive position by appropriate means such as a spring (not shown) so that pinions 84 and 85 are withdrawn from the corrective gears and the abutment portion 81 is withdrawn from the paths of stops 53 and 75. At this time the secondary clock is thus allowed to resume its normal operation. An hourly correction of this type is accomplished by a signal sent by the master clock once each hour.

At the time for a twelve-hour correction, for instance at approximately 5:05, a series of twelve signals similar to the hourly corrective signals are transmitted by the master clock and thereby a correction of up to twelve hours may be accomplished at the secondary clock. If the secondary clock is correct at the time for these signals, the co-action between switch 21 and detent 44 on cam 22 will effect opening of the switch 21 and will hence open the circuit to signal responsive means 18 so that the signal sent out by the master clock will be ineffective at the secondary clock. During this time the motor 17 will continue to operate and the clock will merely continue to run at its normal rate. Shortly after the completion of this series of corrective signals, cam 22 will again close switch 21 and the secondary clock will again be in condition to receive a corrective signal at the next hourly correction.

FIGURES 3 through 5 illustrate a preferred embodiment of my invention as it may be utilized in secondary clocks for commercial purposes. As seen therein the clock includes a back plate 90 and a front plate 91. Plates 90 and 91 are held in spaced parallel relationship by spacing pillars 92 located at three corners thereof and held in place by appropriate means such as screws 93. At the fourth corner, the plates 90 and 91 are spaced by an enlarged diameter pillar 94 which has formed therein, intermediate its ends, an annular groove 95 (see FIGURE

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4) surrounding a reduced diameter portion 96. Pillar 94 is held in place by a pair of screws 97 at each end and having their heads on the outside of the plates 90 and 91.

Rotatably mounted on the spacing pillar 92 at the lower left of the clock assembly, (see FIGURES 3 and 4), is the movable member 80. Member 80 has a sleeve-like portion 100 which encircles the pillar 92 and hence the co-action of these two members provides a pivot for the member 80. At its upper end, as seen in FIGURE 3, member 80 has two upstanding leg portions 101 and 102 with a space 103 formed therebetween. The groove 95 in pillar 94 accepts this U-shaped portion of member 80 and the amount of pivotal movement of member 80 is limited by the co-action of legs 101 and 102 with the reduced diameter portion 96 of pillar 94. Member 80 is biased in a counterclockwise direction by a torsion spring 104 acting at the lower end of the member adjacent cylindrical portion 100. Rotatably mounted on member 80 are the pinions 84 and 85 which are axially aligned with corrective gears 50 and 73 and adapted to engage said corrective gears when member 80 is moved to a correcting position.

Shafts 62 and 77 are journalled at each of their ends in the plates 90 and 91. Output shaft 46 of the motor 17 is journalled in the rear plate 90 and hour member 55 is journalled at its forward end in the front plate 91. Shaft 70 is journalled at its forward end in plate 91. Also journalled in plates 90 and 91 is a manual reset shaft 105 having mounted at its forward end a pinion 106 which is adapted to engage gear 67 which, as pointed out in connection with FIGURE 2 is fixed on shaft 70 and is in engagement with gear 66 which is in turn mounted on the minute member 54. At its rearward end shaft 105 has a manual reset knob 107. By rotation of the knob 107, and hence shaft 105, the secondary clock may be individually manually reset if desired.

As best seen in FIGURE 5, signal responsive means 18 may be a solenoid having a winding 110 wound on a bobbin 111. Bobbin 111 is mounted within a U-shaped member having upstanding leg portions 112 and 113 at either end of the bobbin. Intermediate legs 112 and 113 is a bite portion (not shown) which is attached by screws or other appropriate means to one leg of an angle member 14 which is mounted by its other leg on the back side of back plate 90 by appropriate means such as screws 115. Movably mounted within an axial aperture within the center of the coil and passing through an aligned aperture in leg 112 of the frame member, is a solenoid plunger 116. Plunger 116 is connected by appropriate means such as a spring 117 to a leg portion 120 extending from member 80 and substantially perpendicular thereto at the end of member 80 adjacent the enlarged pillar member 94. Bobbin 111 has at one end a terminal portion 121 at which conductors such as 15 and 20, as discussed in FIGURE 1, may be attached to the solenoid winding 110.

Switch 21, as best seen in FIGURE 3, may be any conventional switch and is attached to an extending ear portion 122 of rear plate 90 by appropriate means such as screws 123. Switch 21 is a normally open switch which is, during the major portion of each twelve hour period, maintained in a closed position by the action of a cam follower member 124 which is pivoted at 125 and which has at its outermost end a follower portion 126 which engages the periphery of cam 22. Adjacent pivot 125 follower member 124 engages a switch actuating member 127 which is normally biased outwardly from the switch by means not shown and hence actuating member 127 tends to bias follower member 124 in a counterclockwise direction and maintains follower portion 126 in a constant engagement with the periphery of the cam 22. Switch 21 is adapted to be connected to a pair of conductors such as conductors 20 and 27 as discussed in connection with FIGURE 1.

Clutch 52 may be of any conventional friction clutch type but it is preferably of the type shown in FIGURES 11 and 12 of the Kleimeyer Patent Number 3,028,722. Clutch 52 is effective to normally provide a driving connection between gear 50 and the seconds member 51 but will allow slippage when member 51 is stopped so that the motor may continue to run. Similarly clutch 65 through which gear 64 is connected to minute member 54 normally maintains the two members in driving relation but when the minute member is stopped, the clutch allows slippage so that the motor 17 and hence gear 64 may continue to rotate. Clutch 65 may also be of any conventional slip clutch construction but is preferably comprised of two friction disks 128 and 129 (see FIGURE 4) mounted on minute member 54 adjacent each side of gear 64. The forward one, 128 of these two friction disks is located between gear 64 and pinion 66 which is rigidly mounted on minute member 54, and is in frictional engagement with the adjacent sides of these two gears. The friction disk 129 on the rear side of gear 64 is pressed against the gear by the action of a spring 130 located immediately forward of the corrective gear 73. Spring 130 acts between corrective gear 73 which is rigidly mounted on the minute member 54 and the friction disk 129 to press it into engagement with gear 64. A spring 131 acts between the forward most end of clutch 52 and the rear side of gear 73 and urges the entire minute assembly in a forward direction.

The operation of the secondary clock has been described somewhat briefly previously herein but will now be described in detail with reference to FIGURES 3 through 5. As pointed out previously, pivoted member 80 is normally maintained in an inactive position due to the action of torsion spring 104. During all periods except for the period between approximately 5:03 and 5:25 of each twelve hour period, switch 21 is maintained in a closed position by the action of cam 22 on follower 124. Once each hour, for instance at approximately fifty-eight minutes past the hour, a signal of approximately fifty-five seconds duration is sent by the master clock. Coil 110 of signal responsive means 18 is thus energized and plunger 116 is drawn into the aperture of the solenoid. Acting through spring 117, this movement of the plunger urges pivoted member 80 in a clockwise direction to its correcting position and brings pinions 84 and 85 into engagement with corrective gears 50 and 73 respectively. At the same time abutment portion 81 of member 80 is moved into the paths of stops 53 and 75 on the seconds member 51 and the corrective gear 73 respectively. Spring 117 which connects member 80 to solenoid plunger 116 provides a resilient connection and hence insures proper meshing of pinions 84 and 85 with corrective gears 50 and 73.

If, at the time that this hourly corrective signal is received by the secondary clock, the secondary clock is correct, blank portion 74 on corrective gear 73 will be adjacent pinion 85 and, although pinions 84 and 85 are rotated by corrective gear 50, no acceleration of the minutes member through gear 73 will be accomplished. Stops 53 and 75 will engage abutment 81 and hence the seconds and minutes members will be prevented from rotating until the corrective signal is terminated. Upon cessation of the corrective signal, torsion spring 104 again moves member 80 in a clockwise direction (as seen in FIGURE 3) to an inactive position.

If, upon receipt of the hourly corrective signal from the master clock, the secondary clock is slow, blank portion 74 of corrective gear 73 is not adjacent pinion 85 and hence, when member 80 is moved to a correcting position, gear 73, and hence minute member 54, is rotated at a speed substantially sixty times its normal rate of rotation. It will be seen that since the corrective signal is of approximately fifty-five seconds duration any error of up to about fifty-five minutes may be corrected. When the minute member has been rotated to the desired position, blank portion 74 on gear 73 is adjacent pinion 85

and stop 75 will engage abutment 81. Similarly, when seconds member 51 reaches the desired position, stop 53 thereon engages abutment 81 and the seconds and minutes members are held stationary until cessation of the corrective signal at which time they are again released and allowed to continue at their normal time keeping rate.

When the secondary clock indicates approximately 5:03 follower portion 126 of follower member 124 drops into detent 44 on cam 22 and switch 21 is opened, breaking the circuit to signal responsive means 18. At approximately 5:05 the master clock begins to send out a series of twelve separate signals each having a duration of approximately sixty-five seconds and separated by approximately twenty-five seconds. If the secondary clock is correct at this time switch 21 is open as described above and the signals sent by the master have no effect upon the secondary clock. However, if the secondary clock is incorrect at this time, switch 21 remains closed and upon receipt of each of the signals a correction of up to one hour is made at the secondary clock. During the twenty-five seconds between these signals, member 80 is moved to an inactive position and the secondary clock proceeds at its normal rate but as soon as the next signal is received a further correction of up to one hour may be accomplished. It will be seen that correction of an error of up to twelve hours can thus be accomplished but as soon as the secondary clock indicates approximately 5:03 switch 21 is opened and further signals from the master have no effect upon the secondary. Thus, if the secondary clock is slow at the time the twelve-hour correction signals are received, the hour hand will always be moved to a correct position before switch 21 is opened. However it may occur that the minute hand will not, at the time switch 21 is opened, be at exactly the correct position but this is not a serious matter since a normal hourly correction will take place at 5:58 at which time the minute hand will again be brought to the correct position.

It will be obvious that the times mentioned above for the receipt of hourly and twelve-hour corrective signals are by way of example only and that the hourly correction may take place any time during each hour as determined by the adjustment of the cams in the master clock. Similarly the twelve-hour correction may be made at any desirable time during each twelve-hour period. However it has been found convenient in many applications, particularly in schools, to have the twelve-hour correction take place at some time when the building is normally unoccupied and it has been found that between 5:00 and 6:00 o'clock is a particularly desirable time.

FIGURE 6 discloses a modification of my invention wherein the cam 22, gear 76 and shaft 77 have been completely eliminated. The structure of FIGURE 6 is, in other respects, identical to that disclosed in FIGURES 3 through 5 but in FIGURE 6 certain elements have been removed to more clearly show the modification to my invention. Replacing the cam 22 is a cam member 130 which is mounted directly on hour member 55 and rigidly fixed thereto. Cam member 130 is mounted immediately forward of gear 64. Cam member 130 has formed therein a notch 131 which corresponds to a period of approximately 22 minutes out of each twelve hour period. Switch 21 has been inverted from the position in which it was mounted in the embodiment shown in FIGURES 3 through 5. Follower arm 124 has been replaced by an arm 132 which is pivoted at 125 and which extends substantially vertically downward from the pivot. At its lower end arm 132 has a follower portion 133 which normally engages the periphery of the cam 130. Arm 132 engages the switch actuating member 127 and normally maintains the switch in a closed position, thus completing the circuit to solenoid 18. Cam 130 is arranged on hour member 55 so that the notch 131 is adjacent follower 133 during the period between 5:03 and 5:25 of each twelve hour period. Since the switch actuator 127 is spring biased outward, the follower portion 133 moves

into the notch 131 at this time and allows the switch to open.

The operation of the embodiment of my invention shown in FIGURE 6 and discussed above is similar to that discussed in connection with FIGURES 3 through 5 and therefore a detailed discussion of the operation will not be repeated.

FIGURE 7 discloses a further embodiment of my invention. The structure shown therein is similar to that of FIGURE 6 with the exception that the switch 21 has been eliminated and mechanical means have been substituted therefor to interrupt a twelve-hour correction of the secondary clock if the clock is correct during the twelve-hour correction period. Cam 130 is mounted on the hour member 55 directly forward of gear 64 as described in connection with FIGURE 6. An interrupter member 140 includes a leg portion 141 which is pivoted about the spacing pillar 92 at the lower righthand corner of the clock movement as seen in FIGURE 7. A follower portion 143 extends from leg 141 and is adapted to engage the periphery of cam 130. Biasing means such as a spring 144 urges member 140 in a counterclockwise direction so that follower 143 is maintained in contact with the periphery of the cam. The co-action of the follower 143 and the periphery of cam 130 normally maintains member 140 in a first or inactive position. Spring 144 has one of its ends connected to leg 141 and its other end connected to an eyelet 145 which is connected to the rear plate 90 of the secondary clock. At its upper end, leg 141 has extending therefrom a portion 146 which extends substantially perpendicular thereto and generally horizontally as seen in FIGURE 7. An abutment portion 147 extends generally perpendicular to portion 146 and toward the backplate 90 of the secondary clock.

Cam 130 is fixed on hour member 55 such that notch 131 is adjacent follower portion 143 during the period between approximately 5:03 and 5:25 of each twelve hour period. Due to the action of spring 144, member 140 is constantly urged in a counterclockwise direction and hence during this period the follower 143 drops into notch 131. This releases the member 140 and permits it to rotate in a counterclockwise direction to a second or active position wherein abutment portion 147 engages a surface 148 of pivoted member 80 and prevents member 80 from rotating to a correcting position wherein the pinion 84 and 85 engage the correction gears 51 and 73.

As has previously been discussed herein, and as best seen in FIGURE 5, pivoted member 80 is connected to the plunger 116 of the signal responsive solenoid 18 by a spring 117. This spring provides a resilient connection between the solenoid operator and the pivoted member. Spring 144 is chosen so that when follower 143 has dropped into notch 131 in the cam 130 and hence member 140 has rotated to the position wherein it engages pivoted member 80, spring 144 has sufficient strength to maintain pivoted member 80 in an inactive position even though the solenoid is energized. However spring 117 may preferably be chosen such that at this time plunger 116 is allowed to pull in upon energization of the solenoid coil by simply expanding the spring 117. By so doing certain problems, such as heating of the solenoid and chatter which might result if the solenoid were energized but the plunger not allowed to pull in, are avoided.

The operation of the secondary clock of FIGURE 7 is similar to that described in detail in connection with FIGURES 3 through 5. Once each hour the solenoid 18 is energized by a corrective signal and, acting through the spring 117, the plunger moves pivoted member 80 to a corrective position. During each of these hourly corrections, interrupter member 140 has no effect on operation of the clock because it is held in its inactive position by the co-action of cam 130 and follower 143.

When the time for a twelve-hour correction arrives, follower 143 drops into notch 131 if the secondary clock indicates correct time and spring 144 moves interrupter

member 140 to its active position wherein abutment portion 147 engages surface 148 on pivoted member 80. Thus even though solenoid 18 is energized, member 80 is held in its inactive position and the only effect of the movement of plunger 116 is to stretch spring 117. If the secondary clock is incorrect at this time, and hence requires correcting, notch 131 will not be adjacent follower 143 and member 140 will be maintained in its inactive position, allowing member 80 to move to its correcting position. After a sufficient number of corrective signals has been received to bring the hour indicator of the secondary clock to the correct position, follower 143 drops into notch 131 and member 140 is moved to its active position in abutment with member 80. Thus further corrective signals do not effect the setting of the clock. At the end of the twelve-hour correction period, cam 130 has rotated to a position wherein notch 131 has moved past follower 143 and member 140 is returned to its inactive position where it is maintained until the hour member of the secondary clock again reaches a position corresponding to a twelve-hour correction period.

From the foregoing it can be seen that my invention provides an improved secondary clock having means for automatic correction thereof. The secondary clock mechanism is extremely simple hence making it easy to assemble and relatively inexpensive. The system contains very few moving parts and, when an hourly corrective signal is received and the secondary clock is correct, the pinion 85 merely rotates in the blank portion of the periphery of corrective gear 73. During a twelve-hour correction period, if the secondary clock is correct, the circuit to the signal responsive solenoid is opened or, as an alternative, the solenoid is energized and the plunger allowed to pull in but the corrective mechanism is maintained in an inactive condition by a simple mechanical mechanism. Slip clutch 65 is not slipped during either of such corrective periods and hence wear on the slip clutch is practically eliminated. Thus the reliability of the corrective system has been substantially improved and due to the small number of moving parts, the noise produced during a corrective cycle has been substantially reduced.

While I have shown and described certain preferred embodiments of my invention, it is to be understood that these are for illustrative purposes only and that, obviously, various modifications thereof will become apparent to those skilled in the art. It is therefore to be understood that my invention is to be limited only by the scope of the appended claims.

I claim as my invention:

1. A secondary clock comprising: motor means; a rotatable time member; drive means operably connecting said motor means and said time member for driving said time member at a normal time keeping rate; a first correction gear operably connected to said time member and normally rotating at a predetermined rate; a second correction gear operably connected to said motor means and normally rotating at a relatively higher rate, said first and second correction gears having generally parallel axes of rotation; normally stationary rotatable pinion means selectively movable in a direction generally transverse to the axis of rotation of said correction gears between an inactive position wherein said pinion means is disconnected from said drive means and is not rotated by said drive means, and a correcting position wherein said pinion means operably connects said first and second correction gears so that said first correction gear is driven at an accelerated rate; means normally maintaining said pinion means in said inactive position; signal responsive means adapted upon receipt of a corrective signal to move said pinion means to said correcting position; and means for interrupting the accelerated drive of said first correction gear when said time member is in a predetermined angular position.

2. In a secondary clock of the type including motor means having an output shaft adapted to rotate at a

uniform speed, a rotatable minute member, a rotatable seconds member, drive means operably connecting said output shaft to said minute and seconds members for driving said members at normal time keeping rates, the improved automatic correction apparatus comprising: a first correction gear operably connected to the minute member and normally rotating at a predetermined rate; a second correction gear operably connected to the output shaft and normally rotating at a relatively higher rate, said first and second correction gears being rotatable about parallel axes; a movable member; normally non-driven pinion means rotatable about an axis parallel to the axes of rotation of said correction gears and mounted on said movable member; said movable member being selectively movable transversely to the axes of said pinion means and said correction gears between an inactive position wherein said pinion means is not driven and a correcting position wherein said pinion means operably connects said first and second correction gears so that said first correction gear is driven at an accelerated rate; means normally maintaining said movable member in said inactive position; signal responsive means adapted upon receipt of a corrective signal to move said movable member to said correcting position; means operable by said signal responsive means and effective only when said movable member is in said correcting position for stopping said seconds member at a predetermined angular position, the last named means including a stop member associated with said seconds member and rotatable therewith and abutment means movable with said movable member and intersecting the path of said stop member only when said movable member is in said correcting position; and means for interrupting the accelerated drive of said first correction gear including a blank portion on the periphery of said first correction gear and adapted to be adjacent said pinion means when said minute member is in a predetermined angular position.

3. A secondary clock comprising: motor means; a rotatable minute member; a rotatable hour member; first drive means operably connecting said motor means and said minute member for driving said minute member at a normal time keeping rate; second drive means operably connecting said minute member and said hour member for driving said hour member at a normal time keeping rate; a first correction gear operably connected to said minute member and normally rotating at a predetermined rate; a second correction gear operably connected to said motor means and normally rotating at a relatively higher rate, said first and second correction gears having parallel axes of rotation; normally non-driven pinion means rotatable about an axis parallel to the axes of said correction gears and selectively movable in a direction generally transverse to the axes of said pinion means and said first and second correction gears between an inactive position wherein said pinion means is not driven and a correcting position wherein said pinion means operably connects said first and second correction gears so that said first correction gear is driven at an accelerated rate; means normally maintaining said pinion means in said inactive position; signal responsive means including a member movable in response to an electrical signal; electrical means adapted for connecting said signal responsive means into a circuit including a source of periodic corrective signals, resilient means connecting the movable member of said signal responsive means to said pinion means so that upon receipt of a corrective signal said signal responsive means moves said pinion means to said correcting position; means for interrupting the accelerated drive of said first correction gear when said minute member is in a predetermined angular position; and means associated with said hour member and maintaining said pinion means in an inactive position irrespective of the receipt of a corrective signal when said hour member is in a predetermined angular position.

4. The secondary clock of claim 3 wherein the last

named means includes normally closed switch means connected in said electrical means in series relationship with said signal responsive means; and cam means operably connected to said hour member and operably associated with said switch means, said cam means being constructed and arranged to open said switch means when said hour member is in said predetermined angular position.

5. The secondary clock of claim 3 wherein the last named means includes a rotary cam member operably connected to said hour member and having a contoured portion on the periphery thereof corresponding to said predetermined angular position of said hour member; an interrupter member mounted in said secondary clock and movable between first and second positions therein, said interrupter member including an abutment portion adapted to engage and retain said pinion means in said inactive position when said interrupter member is in said second position; spring means biasing said interrupter member to said second position and of sufficient strength to maintain said pinion means in said inactive position and to override the effect of said signal responsive means upon receipt of a corrective signal; and follower means associated with said interrupter member and maintained in engagement with the periphery of said cam member by the last named spring, said cam member and said follower means co-acting to normally maintain said interrupter member in its first position wherein it does not effect said pinion means, said contoured portion being so formed that said interrupter means is moved to its second position and said pinion means is maintained in its inactive position thereby when the contoured portion of said cam means is adjacent said follower means.

6. A secondary clock comprising: a rotatable hour sleeve; a minute sleeve rotatably mounted in said hour sleeve; a seconds shaft rotatably mounted in said minute sleeve; hour, minute and second indicating means mounted on said hour sleeve, said minute sleeve and said seconds shaft respectively; synchronous motor means having an output shaft; first driving means including friction driving means operably connecting said seconds shaft to said output shaft of said motor means; second drive means including friction drive means operably connecting said minute shaft to the output shaft of said motor means; third drive means operably connecting said hour sleeve and said minute sleeve, said first, second and third drive means being effective upon energization of said motor means to drive said seconds shaft, said minute sleeve and said hours sleeve respectively at a normal time keeping rate; corrective drive means for accelerating rotation of said minute sleeve including a first correction gear mounted on said minute sleeve and rotatable therewith; a second correction gear substantially coaxial therewith and driven by the output shaft of said motor means at substantially the same speed as said seconds shaft; a pivoted member movable in a plane generally transverse to the axis of said correction gears; first and second non-driven integrally connected pinions mounted on said pivoted member and rotatable about an axis parallel to the axis of said correction gears and adapted to engage said first and second correction gears respectively to form a driving connection therebetween to drive said first correction gear at an accelerated rate; yieldable means normally urging said pivoted member to an inactive position wherein said pinions are out of engagement with said correction gears; corrective signal responsive solenoid means including a member movable in response to a corrective signal; circuit means adapted to connect said solenoid means to a source of corrective signals, yieldable spring means operably connecting said movable member of said solenoid means to said pivoted member so that said solenoid means is adapted, upon receipt of a corrective signal, to move said pivoted member to a correcting position wherein said pinions engage said correction gears; means effective when said pivoted member is in said cor-

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recting position to stop said seconds shaft at a predetermined angular position including a stop member mounted on said seconds shaft and an abutment portion on said pivoted member, said abutment portion being moved into the path of said stop member only when said pivoted member is in said correcting position; means for interrupting the accelerated drive of said minute sleeve when said minute sleeve reaches a predetermined angular position, said last named means including a blank portion on the periphery of said first correction gear and adapted to be adjacent said first pinion when said minute sleeve is in said predetermined position; stop means mounted on said first correction gear and adapted, when said pivoted member is in a correcting position, to engage said abutment means when said minute sleeve is in said predetermined angular position; rotary cam means driven synchronously with said hour sleeve; and means operable by said cam means and effective to maintain said pivoted member in said inactive position irregardless of the receipt of a corrective signal at said secondary clock when said cam means is in a predetermined angular position.

7. The secondary clock of claim 6 wherein the last named means includes normally closed switch means connected in said circuit means in series relationship with said solenoid means; and switch operating means operable by said cam means to open said switch means when said cam means is in said predetermined angular position.

8. The secondary clock of claim 6 wherein said cam means includes a rotary cam member having a contoured portion on the periphery thereof corresponding to the

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period during which a twelve-hour correction is accomplished; and wherein said means operable by said cam means includes an interrupter member mounted in said secondary clock and movable between first and second positions therein, said member including an abutment portion adapted to engage said pivoted member and to maintain said pivoted member in said inactive position when said interrupter member is in said second position; spring means biasing said interrupter member to said second position, the last named spring means being stronger than the spring which connects the movable member of said solenoid means to said pivoted member; and follower means associated with said interrupter member and maintained in engagement with the periphery of said cam member by said last named spring, said cam member and said follower means co-acting to maintain said interrupter member in said first position except when said contoured portion of said cam is adjacent said follower means, said contoured portion being so formed that said interrupter means is moved to said second position when said contoured portion is adjacent said follower means.

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